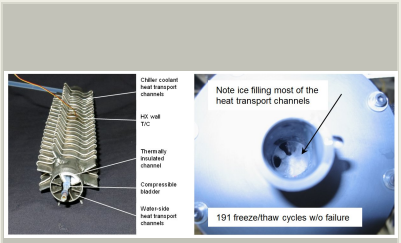
A Self-Regulating Freezable Heat Exchanger for Spacecraft, Phase II

Completed Technology Project (2013 - 2015)

Project Introduction

A spacecraft thermal control system must keep the vehicle, avionics and atmosphere (if crewed) within a defined temperature range. Since water is non-toxic and good for heat transport, it is typically used as the coolant that circulates within the crew cabin boundary. This loop then interfaces with another low freeze point fluid, such as ammonia, for transport of heat to a radiator where the temperatures can be considerably below the freezing point of water. The volumetric expansion during freeze usually prevents its use in external systems since freezing will damage the components. Yet, if the system can accommodate the forces generated by freezing, then selectively allowing parts of a heat exchanger to freeze can be used to passively increase the turn-down of the heat rejection from radiators. TDA Research, Inc. has been developing freezable water/ice phase change heat exchangers for several years that offer several advantages: they can eliminate the need for a separate heavy Freon or ammonia loop; use the buildup of ice to regulate the rate of heat transfer, and the endotherm of melting ice can absorb peak loads from the spacecraft to reduce the size and mass of the radiator. Therefore, TDA Research and the University of Colorado set out to demonstrate a lightweight and freeze tolerant water/ice heat exchanger to passively regulate the heat rejection rate from the water coolant loop of a manned spacecraft to its heat sink systems. The heat exchanger has no actively moving parts and is thus extremely reliable. In Phase I, we designed and built a self-regulating freezable heat exchanger that we put through 191 freeze/thaw cycles without damage and it has the capability to transfer the loads expected in crewed spacecraft. In Phase II, we will design, build and test a large-scale freeze tolerant water/ice heat exchanger that forms the heart of a thermal control system that we will deliver to NASA.



A Self-Regulating Freezable Heat Exchanger for Spacecraft Project Image

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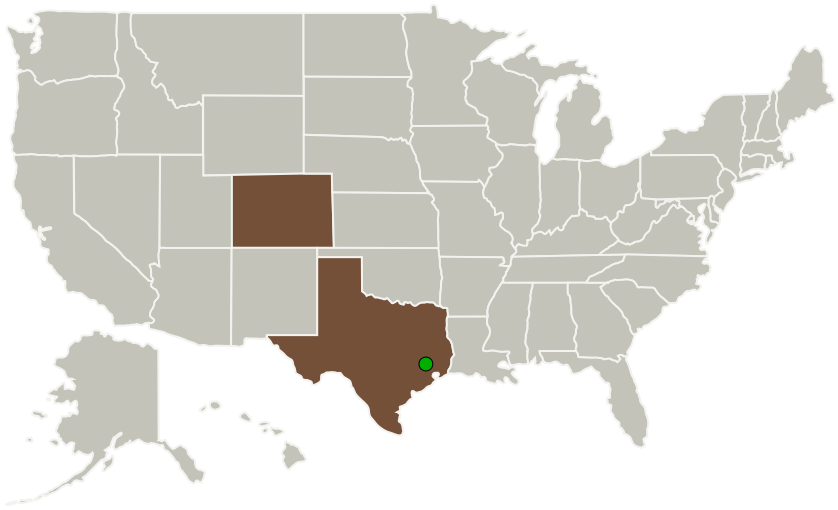
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
TDA Research, Inc.	Lead Organization	Industry	Wheat Ridge, Colorado
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas
University of Colorado Boulder	Supporting Organization	Academia	Boulder, Colorado

Primary U.S. Work Locations	
Colorado	Texas

Project Transitions

July 2013: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

TDA Research, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Robert A Copeland

Co-Investigator:

Robert E Copeland

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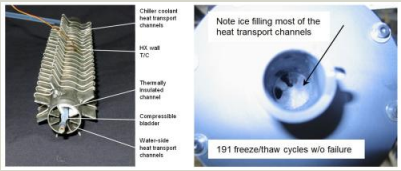
August 2015: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137326)*

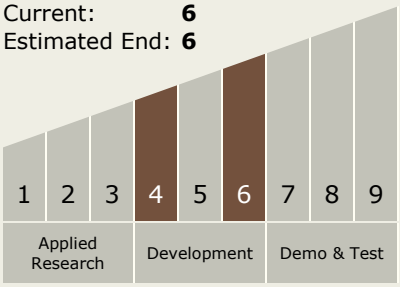
Images



Project Image
A Self-Regulating Freezable Heat Exchanger for Spacecraft Project Image
(https://techport.nasa.gov/image/136822)

Technology Maturity (TRL)

Start: **4**
Current: **6**
Estimated End: **6**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.2 Thermal Control Components and Systems
    - TX14.2.3 Heat Rejection and Storage

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System